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CONTENTS

Critical remarks on the use of gun-fire against hail, p. 17.

Apropos of host-plants of the Lima bean pod borer, *Etiella zinckenella*, p. 27.

Third contribution to locust bibliography, p. 28.

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CRITICAL REMARKS ON THE USE OF GUN-FIRE AGAINST HAIL *

I. — General [1]

As far as is known, the only way of combating hail is by means of gun-fire. This practice dates back to the middle ages, when already the first fire arms were employed in combating hail. Later, in place of the fire-boxes and mortars first used, came the anti-hail guns and hail-cloud rockets. The practice of firing against hail became particularly widespread at the end of the 19th century. The experiments then made began in 1896 at Windisch Feistritz, Styria, in which case an iron funnel was placed on the mortar transforming it into a anti-hail gun.

In the beginning, these guns seemed effective, and a particular effect was attributed to the swirling gaseous tore following discharge. Consequently, in many countries of Europe and even in America, anti-hail guns were set up. It was only in 1907 that after numerous failures, the uselessness of this method of controlling hail was recognized, and the method abandoned. Nervertheless, until now, manufacturers and agents well versed in business matters have known how to boost their anti-hail rockets with the usual advertising.

At all times opinions on the practice of firing against hail were divided even at its zenith, because in no case was it possible to ascertain definitely the result. If guns were fired and it did not hail, the partisans of this practice attributed the fact to this control measure ; on the other hand, if it hailed all the same, these partisans considered it due to delay in starting control operations or to insufficient intensity in gun-fire. The opponents of this system based themselves primarily on the cases in which it hailed despite firing ; on the other hand, if it did not hail, they said it would not have hailed anyhow.

Thus for a long time there was much controversy in regard to the value of gun-fire as a means of checking hail until the authorities took up the question and eminent scientists studied the possibilities of this practice. They agreed almost unanimously that the available means of combating hail were of practically no value. In the first place, it was pointed out that the hail-cloud rockets, rising at the most to a height of 1200 metres, could not reach the hail-cloud situated much

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* Communication from Dr CURT ROMMEL, Privatdocent at the University of Bern, Switzerland.

[1] The numbers in square brackets refer to the bibliographical index given at the end of this article.

higher. Moreover, the blasting action of the rockets is far too weak to destroy the hail-cloud to any extent even when the cloud is hit.

Among the numerous opinions expressed on the subject, we cite some passages which characterize the contrary viewpoint of science from the end of the 19th century up to the middle of the 1930-40 decennary.

Prof. PERNTER [2], Director of the Central Institute of Meteorology and Geodynamics of Vienna, states his opinion as follows: —

" With this, the question is settled for all scientific circles and also for all agriculturists accustomed to thinking objectively. Considering the failures of Windisch Feistritz and Castelfranco and also the uselessness of rockets and bombs, as proved from the experiments carried out in Italy, we are justified in saying: the use of gun-fire in checking storms has had its day.

Certainly, in the future, there will still be individuals who, despite everything, will seek security in this method. Science, however, is justified in abandoning them to their illusions; for us, the question is settled ".

Prof. Dr. E. KLEINSCHMIDT [3] has demonstrated in several articles, that the practice of firing against hail should be rejected not only for empirical reasons but also for those of a physical nature. The 1500 calories which a rocket of 1 kg. emits, at the best, can have absolutely no effect against the force several million times greater put forth in the clouds when hail forms. Moreover, as rockets usually only rise to a height of 700-800 metres, it is very doubtful if they reach the hail-clouds situated for the most part at heights of over 1000 m. Conscientiously carried out experiments and reasons of a physical nature show that the control of hail by means of rockets is worthless.

The same opinion was also held by the WURTEMBERG HOME OFFICE which, to a question raised within the Landtag of Wurtemberg on the use of gun-fire against hail replied in these terms " the control of hail by means of rockets has, up to the present, given no demonstrable results, and every pfennig spent on this practice is money wasted ".

Prof. Dr. HUBER [4], chief observer at the Bavarian Meteorological Observatory, Munich, expressed himself as follows: —

" The problem of how to influence the weather and, in particular, to check hail, interests all states of the world, none of which has as yet obtained any practical success. The task of science has always, in the long run, been to serve the mass, even when, at first, the object of research was not easily understood.

In the case in question of the control of hail by means of rockets, our task is to show the uselessness of expending money on same. We prefer the reproach of scientific pride to the responsibility for the expenditure of more or less large sums.

When the Government disposes of financial means to elucidate the question, in the first place encouragement should be given to scientific research. It is only when such questions have a scientific basis that practical application can be started".

In a report drawn up in the spring of 1935, the STATE METEOROLOGICAL INSTITUTE AT PRAGUE, rejected very definitely the use of gun-fire against hail. Besides the different reasons of a meteorological order, against this practice an

economic reason is also advanced. As regards the ' Sirius ' rocket, it is calculated that its use against hail would cost 2 to 3 times more than the damage caused by this calamity [5].

From these diverses citations it appears therefore, that up to the middle of the 1930-40 decennary meteorologists unanimously rejected the use of gun-fire against hail as being ineffective.

II. — The meteorological investigations regarding the use of gun-fire against hail carried out by Colonel Ruby

As the above-mentioned report of the Bavarian Meteorogical Observatory very rightly points out, the question of the use of gun-fire against storms must first be elucidated scientifically before beginning the practical control of hail. The problem was under constant study by a colonel of the air-force F. RUBY (Lyon), who carried out systematic investigations on hail-clouds over a long period before beginning, in 1936, the practical control of this calamity.

While up till then, however, meteorological researches and verifications on thunder-storms and the formation of hail has been effected with the use of kites and balloons, RUBY was the first to study hail-clouds from an airplane. He explored them on every side up to their summits and even above and was thus able to ascertain on the spot phenomena which until then were only presumed to exist or even were as yet unknown.

The investigations of RUBY necessitated both a highly qualified meteorologist and an intrepid airman. The fact that before him no other meteorologist had employed a plane to study rain-clouds shows that flying through these clouds is extremely hasardous, not only because of the risk of thunderbolts, but also because of the violent atmospheric currents. This is why science should show its gratitude towards Col. RUBY.

As region for investigations, RUBY chose Beaujolais, situated between the Saône and the two crests parallel in direction N-S, which is one of the parts most exposed to hail of all France. Another suitable condition was the close proximity of the flying ground at Lyon-Bron, whence RUBY could reach, within a very short time, the scene of investigations. Finally, the practical control of hail appeared particularly important in Beaujolais, because this region possesses approximately 250 km² of vineyards, not only highly subject to hail, but also of great value.

A· Meteorological researches

The research work of RUBY on the origin of hail not only confirms our theoretical knowledge, but also contributes appreciably towards deepening and extending it. RUBY ascertained *in situ* the different phases of the formation of hail, the ascension and fall of hail-stones, as well as the force and movement of hail-clouds. These exhaustive investigations, combined with what was known until now on the formation of hail, prove the following: —

(1) Every kind of precipitation, including hail, presupposes an evaporation. The latter is all the more intense the moister and more strongly heated the air on contact with the ground.

(2) When evaporation is intense, the air rich in water vapour heated on contact with the ground is carried up to great heights, at rapid speeds estimated by RUBY at 15-20 m. per second.

(3) The air rich in water vapour which rises traverses first the isotherm O which, in the temperate zone, in summer occupies elevations of 3000 to 6000 m. It then enters into the superfusion zone, where water droplets and icicles are found and where small hail is also formed. This zone has a power of approximately 1000 m.

(4) If the upward movement of the masses of hot air is fairly strong, these attain the cold zone, to where they violently carry also the water droplets, icicles and frozen pellets of the superfusion zone. This procedure occurs up to elevations in which the temperature is -15°C. There the icicles and the frozen pellets are covered with a layer of ice or else fused together by melting. This is how hail-stones are formed.

(5) In the regions where the currents of hot air which rise attain the cold zone, whirling movements with horizontal axis are produced, as RUBY ascertained.

(6) The longer the hail-stones remain in the cold zone, turning in the horizontal air swirl, or else the more often they are brought back, during their fall towards the earth, by fresh masses of ascending air, the more they increase in volume and weight. Owing to the fresh additions of ice procured in this way, the hail-stones may become extremely large and heavy, sometimes attaining, according to RUBY, a weight of 1200 gm.

(7) The areas where hail forms, in the cold zone, are, according to the new researches carried out with airplane, very limited ; in fact they only occupy a few hundred metres in the midst of many cubic kilometres which often contain thunder clouds. The same may be said of the horizontal whirling movement within which the hail-stones are carried; it constitutes, like the waterspout, a formation which varies easily.

(8) The masses of hot air which have risen are cooled in the cold zone and fall back to the earth. Their fall is partly very violent, but only occupies little space. If the hail-stones which escape from the whirling movement and are no longer maintained in the atmosphere by the masses of ascending air come into contact with a descending column of air, they sometimes fall to the ground at an extraordinary speed (up to 20 m. per second), because to the speed of the unrestricted fall is added that of the descending masses of air. Consequently a particularly heavy fall of hail takes place.

B. Measures against hail

Taking his meteorological observations as a basis, RUBY comes to the conclusion that fall of hail can quite well be prevented by means of explosions produced either by gun-fire from the ground, or else by dropping bombs from above from aeroplanes.

RUBY proves the importance of his assertions by the control operations against hail which he practised in Beaujolais from 1936 to 1938. In 1936 and 1937, he only freed from hail some parts of the wine district designated beforehand, while in 1938, he was able to protect the entire wine district of Beaujolais between the two hill ranges in the west and the Saône in the east.

Unfortunately, work was interrupted by the world war which broke out in the autumn of 1939, so that some doubt could still be raised as to the success of this system of controlling hail. It may be noted, however, that each year Beaujolais is regularly attacked by a large number of severe hail storms, so that the absence of hail in the protected regions precisely during the years 1936-38 cannot be attributed to chance.

In adopting gun-fire against hail, RUBY sets certain conditions which summed up are as follows : —

I. — PRECISE OBJECTIVE STUDY OF THE WEATHER CONDITIONS OF THE REGION WHERE CONTROL OPERATIONS AGAINST HAIL ARE PRACTISED.

For Beaujolais, the following facts have to be recognized : —

(*a*) A W. E. current of moist air from the Atlantic penetrates into the interior of the country.

(*b*) This moist air encounters an obstacle in the two hill ranges of Beaujolais (700 to 1000 m. ältitude, which follow a S.N. direction for a length of about 40 km. and which are separated by gaps of 6 to 10 km. These ranges are partly denuded and are strongly heated on the western slope by solar radiation.

(*c*) On these denuded slopes, the masses of moist air undergo appreciable heating, which imparts to them a notable upward movement, all the more marked the higher the temperature of the sun.

(*d*) In Beaujolais, the ascension of masses of air depends to a large extent on the composition of the region. The localization of the highest layers of air, where the formation of hail is to be feared, is already known. It only remains to find out if the ascension of the air heated by the sun is sufficiently strong to penetrate into the cold zone.

2. — INDIVIDUAL INVESTIGATIONS ON THE FORMATION AND MOVEMENT OF STORMS IN THE ENVIRONS OF THE REGION TO BE PROTECTED AGAINST HAIL.

These investigations comprise : —

(*a*) A notification service properly run which reports in time, even at great distances, the existence of storms, their direction, rate of propagation, etc.

(*b*) Rapid investigations in the hail control region itself, by means of : observations effected from the ground and from airplane — measurements of the temperature of the different layers of air — localization of the particularly strong ascending currents of air, as well as the summits of cumuli, etc.

3. — EFFECTIVE PROJECTILES.

These projectiles are characterized by an adequate range and as great as explosive force as possible.

(*a*) *Range of projectiles.* — An effective protection of the ground should aim not only at destroying the ascending currents of air, but also at extending its effect up into the cold zone where hail forms. Allowing that isotherm O occupies an elevation of 3000 m. and that it is surmounted by the superfusion zone measuring approximately 1000 m. in thickness, the said cold zone begins at elevations of about 4000 m.

It follows that the hail-cloud rockets employed up to the present, with a lifting power of only 1200 m. at a maximum, cannot have any effect on the part where hail forms and must, consequently, remain ineffective.

Up to 1938, RUBY adopted projectiles having a range of 2000 m. and having effect up to 3500 m. For 1939, he had planned projectiles with a range up to 3000 m. and an effect up to 4500 m. Considering, moreover, that the cloud-cannons were placed in part on the aforesaid hill ranges, at altitudes of 700 to 1000 m., it is seen that the effect of the projectiles employed by RUBY extended up to the cold zone. Everyone knows that with the modern anti-aircraft guns, equal and even greater heights can be attained.

RUBY supplements ground protection by the throwing of bombs. From the airplane, which dominates the thunder-clouds, these latter can be reached from no matter what height, also those where hail forms, at a distance of 6000 m. or more from the ground.

(*b*) *Explosive force of projectiles.* — Besides the range of the projectile, its explosive force is of great importance. The aim should be to employ projectiles having as great an esplosive force as possible, that is to say, projectiles capable, in exploding, to have as extensive effect as possible in the space. The more restricted this effect, the more projectiles required to break up the masses of clouds at the critical points, on the other hand, the more widespread the effect, the less projectiles necessary to finish the operation with a well placed gun.

(*c*) If, on the one hand, operations against hail necessitate increasing as far as possible the range and explosive force of the projectiles, on the other, they should not reduce the security of the population. Precautions, therefore, have to be taken to prevent fragments from the projectiles causing damage to man or to his property, as frequently occurs during anti-hail operations.

An endeavour should be made, therefore, to manufacture projectiles that explosion reduces into such small fragments that, on falling to the ground, they no longer become dangerous. To date this problem has not yet been satisfactorily solved; rather its solution appears to become even more difficult as the range and explosive force of the projectiles increase.

At the time of using the guns, as in air-defense, the alarm could be given and thus warn the population to take shelter. Unfortunately, in practice, this measure is of little use, as the farmer in the field will not abandon his work at a critical

moment when a heavy fall of hail is expected, but will prefer, as shown by experience, to save his crop.

Moreover, in the open country, there is frequently no shelter to be found.

4. — Firing Precision.

Firing precision depends on the following conditions : Rapid and trustworthy observations on the spot — Possibility of air service and hail protection — effective projectiles.

Precision in firing is the keystone in combating hail. It necessitates not only recognizing rapidly and exactly the zones exposed to hail and the vulnerable parts of hail-clouds, but also firing on the right spot. In using gun-fire against hail, the fact that there is no visible object to aim at makes the task much more difficult. Only action regulated to the fullest detail enables successful operation.

5. — Economic Value.

It has often been calculated that to combat hail effectively (if possible), the expense would be higher than the average damage caused. This fact has been proved, *inter alia*, by Kleinschmidt as stated in his article cited earlier on. According to official statistics, from 1906 to 1918 and from 1924 to 1926, in Wurtemburg, the average annual damage caused by hail amounted to 4.6 million RM, while the total anti-hail expenses were estimated at 10.8 million RM.

Before organizing an anti-hail campaign the expenditure should always be estimated, as it is only profitable if the cost is lower than the amount of damage likely to be caused.

To maintain expenditure as low as possible, the aim should be to prevent only the gross losses. These occur only in the case of : —

(*a*) particularly susceptible regions where experience has shown that each year they are affected by numerous and severe attacks of hail ;

(*b*) crops of especially high value exposed to hail damage, such as extensive vineyards, tobacco, fruit trees, etc.

From these aspects anti-hail operations are undoubtedly profitable, as the practical application of the Ruby system has been proved in the Beaujolais district. The following approximate sums (pre-war values) indicate the position : Theoretical annual value of the crops : an average of 40 million francs — Average damage : approximately 10 million francs, namely, 25 per cent. of the theoretical value of the crops — Actual value of the crops (damage deducted) : about 30 million francs — Cost of anti-hail campaign in 1938 : approximately 200,000 francs, that is, 0.5 per cent. of the theoretical value of the crops. If it is taken into account that to compensate fully hail damage to the extent of 25 per cent., an insurer has to ask a premium of at least 25 per cent., the extremely advantageous financial result of the Ruby system practised in 1938 is very evident ; in fact, expenses did not exceed over 1/50 of the insurance premium.

III. Conclusions

A. — The anti-hail system as practised by RUBY, based on the results of his meteorological studies, should be considered, as a rule, as effective, even though at the present time, in view of the brevity of the experiments, a decisive judgement cannot be passed. To what extent, in the future, will the advance in knowledge and practice develop or modify the methods of RUBY ? As yet we cannot say.

B. — To carry out his operations, RUBY chose a really ideal locality. Its special conditions, also as regards the geology and climate, its delimitation, the high value of the wine-crop, etc. have contributed not a little towards the great success and profitableness of the anti-hail campaign.

C. — Under other conditions, less favourable for operations, the results would not have been so important. The following points may be indicated here : —

I. — METEOROLOGICAL AND GEOLOGICAL CONDITIONS OF A REGION.

These conditions affect the results of anti-hail operation in two respects : on the one hand, the path followed by the storms and the areas where the hail falls, on the other, the frequency and intensity of the falls of hail.

(*a*) Movement of storms and localization of hail-fall — Anti-hail operations will have the maximum efficacy where the storms always follow the same path and where the formation of hail insofar as it occurs, takes place most frequently within the same areas. On the other hand, if storms and hail-fall from varying directions are to be expected, in carrying out meteorogical researches and anti-hail operations account has to be taken of these circumstances, which makes investigations not only more complicated but increases the cost of operations.

As mentioned earlier on, Beaujolais is an ideal district for anti-hail operations This may also be the case at Windisch-Feistritz and its environs (in Styria, between Marburg and the Croatian frontier), where the last spurs of the Styrian Alps (Bachegebirge) disappear into the warm valley of the Dreu.

At all events, individual weather researches have to be made for every region requiring hail protection.

(*b*) Frequency and intensity of hail-fall. The frequency and intensity of hail-fall increases the cost of protective operations (thus, for example, control operations during the heavy storm in Beaujolais on August 6, 1938, alone cost 80,000 francs, namely, 40 per cent, of the total expenditure for 1938) ; however, this increase in expenditure diminishes proportionately to the capital invested in the anti-hail campaign, as the protective operations not only cost the munition, but also necessitate numerous squads of men, cannons and aeroplanes.

For this reason control operations will be more successful where in the region to be protected there is the certainty of a large number of severe hail-storms. On the other hand, if they are only occasional, the protective service remains dormant for a considerable time, making it unprofitable.

2. — SUSCEPTIBILITY TO DAMAGE AND VALUE OF THE PROPERTY TO BE PROTECTED.

In anti-hail operations, only the produce susceptible of being damaged and of high value is taken into consideration.

(*a*) Susceptibility to hail. Although sometimes hail-fall damages buildings considerably (for example, the storm on August 2, 1927, which caused damage to windows and roofs to the extent of millions of francs, particularly in the Swiss cantons of Bern, Luzern and Zug), no hail protective service will be instituted because, even in the regions where it hails often, damage to buildings is exceptional. In fact, hail is only rarely sufficient heavy to damage relatively resistant roofs.

Therefore, the true objects of protection against hail are the crops which are much more susceptible to this calamity than buildings.

Even crops, however, vary appreciably in susceptibility to hail. Thus, for example, root crops are much less affected, while fruits, tobacco vines, flowers and sowings prove very susceptible.

As, other conditions being equal, the crops susceptible to hail risk being more severely damaged by this calamity than less susceptible crops, it is in the localities where these latter are grown that control operations will be the most necessary and where they will succeed best.

(*b*) Value of type of crop. This value also plays an important part incalculating the profitableness of anti-hail operations. In fact, the higher the unit value of a given crop, the more profitable control operations. Therefore, it is not by chance that an endeavour is made to protect from damage, with the use of gun-fire, vineyards of great value, as operations have already proved in the wine-growing regions of the Beaujolais. On the other hand, it seems hardly profitable to protect from hail crops of lower value, even if they are very susceptible to damage of this kind.

3. — DELIMITATION OF THE REGION TO BE PROTECTED AGAINST HAIL.

It has already been stated that anti-hail operations only appear advisable when the fall of hail is particularly frequent and heavy and where the type of crop to be protected is very susceptible to this calamity and of great value. It follows that with the use of gun-fire practised according to present methods, there can be no question of freeing from hail an entire country or even only one of its provinces, but that control should be limited to certain selected regions of a country which meet the conditions indicated above.

The method of delimiting a region to be protected remains a question to be solved in each individual case. As a rule, delimitation will be regulated on the degree of hail risk in the region and on the type of crop grown.

Moreover, delimitation will have to conform with the geological conditions of the region. Their diversity may make it necessary to divide the region to be protected into different parts, as was done in the Beaujolais district, where first the region between the eastern hill range and the Saône was protected from hail, and subsequently also the zone separating the western range from the eastern range, namely, the Azergues Valley.

4. — Hail control and insurance.

If, as already mentioned, in a given country, the present hail control measures can only protect certain selected regions, they will not in any way supplement insurance, but, on the contrary, the two systems can compete with each other and even, if necessary, form a mutual assistance. The result would be that, everywhere control does not yet procure the desired success : freedom from hail, in the case of damage, compensation could be obtained from insurance.

Thus, if hail control is combined with hail insurance, the insurer who profits from control operations could place at disposal for same, part of the premiums obtained. Moreover, the State should grant subsidies for hail control, as is frequently done for insurance. If this control is profitable, the premium rates could be reduced in the regions protected and protection extended to other districts.

Seeing that effective control is to the advantage of every farmer of the region, each should participate in the expenses involved. Insurance, therefore, at least in the regions where practised, should be compulsory for all. If this obligation to insure does not yet exist as it does, for example, in Bulgaria and in the Swiss cantons of Vaud and Basel-Town, it is all the more necessary for hail control to be effected in the interests of the public, control, towards which the respective agriculturists should contribute.

Bibliographical index

[1] The literature regarding the use of gun-fire against hail is very extensive. The works published up to 1936 are indicated in the well-known book of Rohrbeck : *Die Hagelversicherung der Welt*, Berlin 1937, S. 140-164. To these references may be added the latest publications indicated by Allix in the *Revue pour l'Etude des Calamités*, Genève, 1939, tome II, nº 5, p. 90. Particular mention should be made of the review of the subject ' Les moyens de défense contre la grêle ' which Col. Ruby made on September 15, 1937 on occasion of the First International Conference for Protection against Natural Calamities, held at Paris. — For questions of meteorology, we consulted the *Lehrbuch der Meteorologie* of Hann and Süring, 4. Auflage, Leipzig 1926.

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APROPOS OF HOST-PLANTS OF THE LIMA BEAN POD BORER, *ETIELLA ZINCKENELLA* *

Two reports of different authors but on the identical entomological subject were presented before the Academy of Agriculture of France in the course of the meeting held on June 2, 1943 (see *Comptes rendus hebdomadaires des séances de l'Académie d'Agriculture de France*, Paris, 1943, tome XXIX, nº 10, p. 292-294).

They regard a cosmopolitan snout moth, *Etiella zinckenella* Treitschke (Lep., Pyralidae), long known as a dangerous pest particularly of leguminous plants cultivated or otherwise useful to man.

A. COUTURIER, of the Station of Agricultural Zoology for the South West, states in the first report that the crop of certain bean-fields in the vicinity of Bordeaux Gironde was damaged at the end of July, 1942 by this parasite, 15 per cent. of the pods being attacked.

In the second report J. SUIRE, of the Agricultural Faunology Laboratory of Montpellier, Hérault, calls attention to a serious invasion observed precisely in the environs of this town during the month of September, 1942, subsequently the same pyralid was again found in the region of Toulouse, Haute-Garonne. This time soybean was the crop damaged.

SUIRE adds that, in the neighbourhood of Béziers, Hérault, Claira, Pyrénées-Orientales and Carcassonne, Aude, the moth was observed, always in 1942, on beans.

COUTURIER and SUIRE agree in estimating that this pest increased to an unusual extent in 1942 in the localities indicated. Moreover, according to the second author, it seems that the insect is on the way to spreading through France and that its caterpillar can change shelter and even plant.

In listing the plants attacked by *E. zinckenella* in the different parts of the world, SUIRE affirms that G. M. HENRY has reported this pyralid as host of *Araecerus fasciculatus* de G. (Col., Anthribidae).

Now this latter scientific name does not pertain to a plant but to a small cosmopolitan beetle known as the nutmeg or coffee weevil, wich is injurious to several crops such as cacao, coffee, areca palm, ginger, nutmeg, sweet potato, maize and, among the leguminous plants, *Tephrosia candida, Crotalaria, Leucaena, Cassia*, etc.

To confirm his assertion SUIRE gives a bibliographical reference.

This refers to a report drawn up by G. M. HENRY, Assistant Entomologist of the Department of Agriculture of Ceylon, and published in *The Tropical Agriculturist*, Colombo, 1916, Vol. XLVII, No. 2, pp. 94-100. At the end of this report (pp. 99-100), HENRY recalls that pods of *Tephrosia candida* pierced by *E. zinchenella* were found in October at Halgranoya. He adds that in December he received from another locality of the island (Peradeniya), pods of this leguminous plant attacked by *A. fasciculatus*.

Therefore, it is not as SUIRE writes, by an evident *lapsus calami*, that *E. zinckenella* is a host of *A. fasciculatus*, but that both are parasites of the same plant *Tephr. candida*.

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* Note by GIULIO TRINCHIERI, International Institute of Agriculture.

THIRD CONTRIBUTION TO THE LOCUST BIBLIOGRAPHY *

The present bibliography comprises the titles of 1038 publications on locusts issued in the different parts of the world and forms a continuation of the first two lists with a total of 1739 titles which were published in 1916 and in 1933 †.

The difficulties inherent in the international situation have unfortunately prevented examining and abstractin many periodicals and other publications which would have furnished still more bibliographical material taken from the original source. Intentionally, therefore, in this third contribution, as in the preceding lists, no mention is made of those publications for which the original text was not available.

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* Drawn up by GIULIO TRINCHIERI, International Institute of Agriculture.

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(*To be continued*).

Prof. UGO PAPI, *General Secretary of the International Institute of Agriculture.*

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